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PRINTED IN GREAT BRITAIN BY RICHARD CLAY AND COMPANY, LTD., BUNGAY, SUFFOLK.

METALLURGICAL ABSTRACTS

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METALLURGICAL ABSTRACTS

(GENERAL AND NON-FERROUS)

Volume 15 FEBRUARY 1948 Part 6

I.—PROPERTIES OF METALS

Indium: A Newcomer in the Field of Commercial Metals. F. Stubbs (*J. Tenn. Acad. Sci.*, 1946, **21**, 178–182; *C. Abs.*, 1946, **40**, 6030).—A review of the discovery, occurrence, metallurgy, physical and chemical properties, and uses of the metal and its alloys. 17 references are given.

Principles of Magnesium Metallurgy. I.—Physical Properties. Williamson Wade Moss (*Light Metal Age*, 1947, **5**, (2), 8–15).—A collection of data from various sources on the mechanical, thermal, electrical, and magnetic properties, and the heat of combustion and inflammability of magnesium metal.—M. A. V.

Ionization of Mercury by Electron Impact. B. Yavorsky (*Compt. rend. (Doklady) Acad. Sci. U.R.S.S.*, 1947, **55**, (4), 307–309).—[In English]. The effective cross-section for the ionization of mercury vapour by electron impact was calculated by a wave function as originally suggested by Eckart.—V. K.

***The Normal Cathode Fall for Molybdenum and Zirconium in the Rare Gases.** T. Jurriaanse, F. M. Penning, and J. H. A. Moubis (*Philips Research Rep.*, 1946, **1**, 225–238; *C. Abs.*, 1946, **40**, 6007).—A reproducible and stable normal cathode drop can be obtained for molybdenum and zirconium by covering the wall of the tube with metal produced by sputtering the cathode. This blackening of all non-cathodic parts is shown to be essential for stability, the fluctuations amounting to but a few tenths of a volt for a 1000-hr. life, either burning or on shelf. The cathode drop for either metal, molybdenum or zirconium, is a function of the gas pressure, and its atomic number. The cathode drop lies between 84·3 and 112·6 V. for molybdenum and between 92·1 and 108·0 V. for zirconium.

***Results of Low-Temperature Research. III.—Electronic Heat of Palladium.** K. Clusius and L. Schachinger (*Z. Naturforsch.*, 1947, [A], **2**, (2), 90–97).—Cf. *Met. Abs.*, 1936, **3**, 110. The atomic heat of a metal at const. pressure C_p usually consists of four parts, namely: (1) a part arising from the lattice vibrations C_g; (2) $C_p - C_v$; (3) the electronic heat C_e, which, according to Sommerfeld, increases linearly with T for free electrons; and (4) a correction given by Born and Brody for the deviation of the lattice vibrations from simple harmonic motion. Hitherto, the electronic heat has only been convincingly demonstrated at low temp., when (2) and (4) disappear. The reasons for the difficulties of its demonstration at high temp. are discussed. For strongly paramagnetic and ferromagnetic metals, part of the atomic heat does vary linearly with T at helium temp., indicating an additional electronic heat, but this is about ten times greater than would be expected for free electrons. For these metals, e.g. palladium, it may be shown that the simple T-law for the electronic heat can no longer be valid at high temp. To discover the law applicable over a greater temp. range, measurements of the true atomic heat of palladium between 12° and 270° K. were made. The C_p values obtained were reduced to C_v and these analysed. It then appeared that the electronic heat was proportional to χ_e, where χ_e denotes the temp.-dependent paramagnetic atomic susceptibility of palladium. Then $C_e = 2{\cdot}22\chi_e T$. A good approximation to the rest-value $C_v - C_e = C_g$ can be made with a Debye function ($\theta_D =$ 275°–295°). The relation given retains its validity up to 1000° K. The

* Denotes a paper describing the results of original research.

† Denotes a first-class critical review.

correction for the deviation from simple harmonic motion may accordingly be assumed to be very small, at least for palladium, since it is not noticeable up to this temp. A value of 9·04 Clausius results for the normal entropy of palladium at 25° C.—F. M.

The Rare Metals of the Earth. W. J. Kroll (*S. African Min. Eng. J.*, 1946, **57**, 541–543; *C. Abs.*, 1946, **40**, 6715).—World production is surveyed, and uses, properties, and preparation methods briefly discussed for boron, barium, titanium, thorium, beryllium, gallium, thulium, zirconium, germanium, and uranium. More intense research is advocated.

Titanium and Zirconium. W. H. Waggaman and E. A. Gee (*Federal Sci. Progress*, 1947, **1**, (5), 18–19).—An elementary account of the properties, sources, and extraction of titanium and zirconium.—R. W. R.

†**Mechanical Properties of Metals at Low Temperatures: A Survey.** L. Seigle and R. M. Brick (*Amer. Soc. Metals Preprint* No. **19**, 1947, 51 pp.).—A critical survey, based on 95 references, of the literature relating to the properties of metals and alloys at sub-atmospheric temp. The survey is divided into two main sections, the first of which covers the properties of polycrystalline aggregates, while the second is devoted to the work carried out on single crystals; in addition, the first section is sub-divided into two parts, the first describing work done using the conventional engineering tests, while the second deals with the more fundamental investigations and theories of the deformation properties of polycrystalline aggregates at low temp. Both ferrous and non-ferrous materials are included in the survey. S. and B. draw a number of conclusions: (1) that only the face-centred cubic metals retain their ductility at low temp.; the embrittlement of iron just below room temp. is paralleled by similar effects in all other body-centred cubic and hexagonal metals; (2) the embrittlement of iron is due to the stress necessary to cause deformation increasing more rapidly than the breaking stress; (3) the embrittlement of iron cannot be explained in terms of strain gradients; (4) the metallurgical factors influencing the change in properties of steel at low temp. have not yet been satisfactorily analysed in most instances; (5) an explanation for the embrittlement of single crystals of hexagonal metals exists in terms of the critical stresses for slip and cleavage.—R. W. R.

***Tempering Effects and the Mechanical Equation of State.** J. C. Fisher and C. W. MacGregor (*Amer. Soc. Metals Preprint* No. **3**, 1947, 12 pp.).—The mechanical equation of state, which postulates that the stress in a metal undergoing plastic flow depends only upon the instantaneous values of temp., strain, and strain rate, is only applicable to materials in which there is no phase change or other process which alters the composition or structure as a function of time. It has recently been shown that the hardness of martensite tempering at const. temp. is a function of a single parameter, p, such that $p = T(1 + k \log_{10} t)$, where $T =$ the absolute temp. and $t =$ time. F. and M. suggest that in a tension test on tempered martensite, the stress at a given temp., strain, and strain rate is also a function of p, it being understood that the degree of tempering indicated by p is reached before the test begins and does not change during the test. To confirm their hypothesis, they determined the true tensile-stress–true-strain curves for 50 specimens of S.A.E. 1045 steel, which had been quenched from 845° C. and tempered for periods of 0·1, 1·0, and 10 hr. at various const. temp. in the range 705°–370° C. They also plotted curves of true stress against p, using the value 0·050 for the constant k; the fact that a smooth curve was obtained constitutes direct confirmation of the hypothesis. Some further tests were also made in which tempered specimens were strained, re-tempered, and finally strained to fracture; the curves obtained after the second tempering were all identical, this treatment having removed the effect of the prior strain. The tempering process is independent of both strain and recrystallization. These results

suggest that the theory may also apply to the more general case where p varies during the test, the stress being a function of the instantaneous value of p.—R. W. R.

***On the Law of Deformation of Amorphous and Polycrystalline Bodies.** G. Gurevich (*Compt. rend. (Doklady) Acad. Sci. U.R.S.S.*, 1947, **55**, (6), 493–496).—[In English]. From a discussion of Maxwell and Newton equations of flow in amorphous and polycrystalline materials, G. derives a relationship between yield stress ($\sigma_{\text{const.}}$) and rate of deformation (v) which is given as $\log \frac{v}{\sigma_{\text{const.}}} = A\sigma_{\text{const.}} - B$, where A and B are constants. This relationship was experimentally verified for a number of materials.—V. K.

Brittle Rupture of Plastic Material. F. K. Th. van Iterson (*Proc. K. Ned. Akad. Wetensch.*, 1947, **50**, (3), 246–251).—[In English]. All material can rupture in two ways, according to which of the following criteria is first fulfilled as the load on a structural part is gradually increased, namely: (1) with perfect plasticity, flowing and contracting like heated glass; (2) with a sudden rupture, when the greatest strain reaches the breaking strain. It is shown that a breakdown in plastic material, e.g. mild steel, will never start at the surface. But a brittle rupture, a sudden laceration, may occur inside such material at a spot where three-dimensional tension prevails. It is shown how such tensions may be set up in a hot-rolled steel beam by rapid cooling and make it liable to brittle fracture under load. This often occurs. Brittle fracture in mild steel indicates tension stress in every direction, indicating the occurrence of three-dimensional stress near the ends of cracks. The existence of such stresses is demonstrated mathematically. Conversely, notches may cause brittle fractures. Often the rupture is explosion-like and spreads far into the material.—F. M.

On the Restricted Applicability of the Principle of Least Work in the Plastic Domain. P. P. Bijlaard (*Proc. K. Ned. Akad. Wetensch.*, 1947, **50**, (4), 397–405).—[In English]. A further mathematical contribution to B.'s work on the statics of stressed steel plates.—F. M.

***The Rigidity Factors of Metal Cables.** M. Panetti (*Real Politecnico di Torino, Laboratoria di Aeronautica* [*Publ.*], No. **188**; (summary) *Aircraft Eng.*, 1947, **19**, (224), 328).—A study is made of the geometry of cables and the laws governing the tightening of the strands with internal pressures (proportional to the tension to which they are subjected) in order to deduce the peripheral transmission of pressure; this is probably more correct than the widely adopted method used by P. in an earlier paper. This simplifies the successive calculations of the friction work, accompanying the bending of a taut cable, under the limiting assumption of inextensible strands, as well as calculations of the tension of curvature deduced in the abstract case of const. radius of curvature. Thus it is possible to separate the investigation of the rigidity factors and of the loosening of curved cables from the mode of bending, and more precisely, from the geometrical characteristics of the deformation associated with the study of rigidity in tension by Findeis and Hellmut Ernst. In conclusion, the laws relating the curvature and the reaction moments are deduced.—J. L. T.

***The Optical Properties of Thin Metal Films.** F. Scandone and L. Ballerini (*Nuovo Cimento*, 1946, **3**, 81–115; *C. Abs.*, 1946, **40**, 5973).—A theory is developed for light transmission through films of non-magnetic metals. The final expressions are treated numerically for silver.

***Measurement by Induction Heating of the Temperature Variations of the Specific Heats of Ferromagnetic Materials.** G. J. Aitchison (*J. Sci. Instruments*, 1947, **24**, (8), 200–202).—In a suitably designed high-frequency induction furnace, heat may be supplied to a metallic specimen at a rate which remains approx. const. over a wide temp. range. If a heating curve is taken

under these conditions, and corrections made for loss of heat to the surroundings, it is possible to obtain a graph which shows approx. the variation of specific heat with temp. Graphs of this kind may be used to study transformation temp., and examples of results obtained for iron, cobalt, and nickel are reproduced.—W. H.-R.

The Theory of Supraconductivity. W. Heisenberg (*Z. Naturforsch.*, 1947, [A], **2**, (4), 185–201).—The conducting electrons in a metal can be approximately conceived as a gas, for which Fermi statistics suffice. The Coulomb repulsion influences the state of this "Fermi-Gas" to a decisive extent. For electrons with less energy than the boundary energy for the gas, the Coulomb forces are relatively unimportant. For electrons with the boundary energy, however, their influence is so strong that the "Fermi-Gas" is no longer a suitable approximation and H. endeavours to find another "model". With its aid, he then discusses some problems of supraconductivity. On the basis of his theory, supraconductivity should apparently be a quite general phenomenon for all electron conductors and not appear only in very special cases. The critical temp. ("Sprungtemperatur") should be higher the denser the electrons are in the controlling energy bands, i.e. the narrower the bands are. Thus, relatively poor conductors should show high critical temp.—F. M.

†**Semi-Conductors.** H. S. W. Massey (*J. Sci. Instruments*, 1947, **24**, (8), 220–224).—Based on a lecture given to the Electronics Group of the Institute of Physics. A general review is given of the electron theory of excess and defect semi-conductors, and of its interpretation of the electrical conductivity, Hall effects, and Peltier and Seebeck effects. The process of rectification at a metal/semi-conductor boundary is discussed, and also the optical properties of semi-conductors.—W. H.-R.

Interatomic Distances in Crystals and the Hume-Rothery Formula. E. S. Sarkisov (*Compt. rend. (Doklady) Acad. Sci. U.R.S.S.*, 1947, **55**, (8), 727–730).—[In English]. By plotting ln d against ln $Z_{\text{eff.}}$, where d is the interatomic distance and $Z_{\text{eff.}} = Z^{2/3}$, it is shown that the slope a of the resulting straight lines is given by the relation $a = 2^{n-2} + 1$, and $d = \dfrac{C_A}{Z_{\text{eff.}} - a}$, where n is the main quantum number. This generalization extends also to B sub-groups in the periodic table, in which case $a = n - 2$, and $d = C_B Z_{\text{eff.}}{}^{n-2}$. —V. K.

II.—PROPERTIES OF ALLOYS

***On the Notch Sensitivity of High-Strength [Aluminium] Alloys.** J. B. Friedman and T. A. Volodina (*Compt. rend. (Doklady) Acad. Sci. U.R.S.S.*, 1947, **55**, (8), 713–716).—[In English]. Tensile tests were carried out on notched specimens in *B*-95 aluminium-base alloy (composition is not given) and on Duralumin under various amounts of eccentric loading. *B*-95 alloy showed a greater loss in ductility under eccentric loading than Duralumin.—V. K.

***Generalized Mechanical Properties of Solid Bodies [Aluminium Alloys].** J. B. Friedman (*Compt. rend. (Doklady) Acad. Sci. U.R.S.S.*, 1947, **55**, (9), 817–820).—[In English]. True stress–strain curves were determined for Dural, aluminium–zinc–magnesium alloys, and various types of steels in different conditions of heat-treatment. General types of stress–strain curves were obtained for different types of loading for all alloys tested with the exception of high-strength steels, after tempering below 500° C.—V. K.

Carbides, Nitrides, and Porosity in Aluminium [Alloys]. Davidlee Von Ludwig (*Iron Age*, 1947, **160**, (21), 73–78, 141).—L. points out that carbides and nitrides are the chief major contaminants in aluminium alloys and questions

the suggestion that hydrogen is the primary cause of porosity in these alloys. He discusses the chemical reactions involving carbon and nitrogen that take place and the conditions under which they tend to cause a reduction in the physical properties. He gives results of an investigation that indicate the lack of correlation between strength properties and the conventional X-ray examination technique, and emphasizes the lack of satisfactory methods for the isolation and identification of minute amounts of active non-metallic constituents.—J. H. W.

Beryllium Copper : the New Alloy. L. Sanderson (*Canad. Min. J.*, 1946, **67**, 862–864; *C. Abs.*, 1946, **40**, 6391).—The properties of beryllium and of the beryllium-copper alloys are discussed. Beryllium copper is susceptible to work-hardening and quickly acquires hardness during forming operations. It can be forged and pressed, and can be soft-soldered in the heat-treated condition. It should be annealed in a furnace with a controlled atmosphere.

***The Heat-Treatment and Properties of Some Beryllium–Nickel Alloys.** W. Lee Williams (*Amer. Soc. Metals Preprint* No. **11**, 1947, 14 pp.).—The precipitation-hardening of an alloy of nickel containing 2·07% beryllium was investigated by following the change in hardness with time, of 0·012-in.-thick specimens heat-treated at the following temp. : 425°, 485°, 540°, 595°, and 650° C. The specimens had previously been solution treated at 1065° C., quenched, and cold rolled; the effect of varying degrees of prior cold work on the course of hardening was examined by investigating three batches of material which had received 25, 50, and 75% reduction, respectively. The hardness measurements were made with a Rockwell Superficial Hardness Tester (15 kg. load), and the results obtained were expressed as hardness–time curves; times up to 4 hr. were investigated. It was found that the cold-rolled materials could be hardened to over 500 Brinell by 2–4 hr. treatment at 460°–485° C. At the higher temp. investigated, max. hardness was reached very rapidly (10 min. at 595° C.), while at 425° C. the hardness was still increasing after 4 hr. The time to reach max. hardness was least with the 75% cold-rolled material, but the max. attainable hardness was nearly independent of the degree of cold work. During the early stages of hardening, no precipitation was visible under the microscope at 1000 dia., although heavy precipitation was observed in over-aged material. The material cold rolled 25 and 50% and hardened at 595° and 650° C. yielded a double-peaked hardness–time curve; this is ascribed to the superimposition of stress relief and recrystallization effects on the hardening. Incipient recrystallization begins about 485° C., the temp. being lower at higher degrees of cold work, and pronounced grain growth begins at about 870° C. Tensile, fatigue, and other mechanical tests and corrosion tests were carried out on $\frac{13}{16}$-in.-dia. bar material containing 1·62% beryllium and which had been solution treated, cold rolled to 35% reduction, and hardened at 485° C. for 4 hr. The following figures were obtained for the mechanical properties : ultimate tensile strength 112 tons/in.^{2}, 0·1% proof stress 89 tons/in.^{2}, elongation 13%, limit of proportionality 70 tons/in.^{2}, elastic modulus $29 \cdot 5 \times 10^6$ lb./in.^{2}, Brinell hardness 460, fatigue strength 29 tons/in.^{2} at 30×10^6 cycles. Corrosion tests carried out in river estuary water revealed severe pitting attack although no general corrosion had occurred after 65 days. The corrosion-fatigue strength in the same water was 13·4 tons/in.^{2} at 30×10^6 cycles.—R. W. R.

***The Sign of the Hall Coefficient [in Bismuth–Antimony Alloys].** A. Carrelli (*Nuovo Cimento*, 1946, [ix], **3**, 40–49; *C. Abs.*, 1946, **40**, 5972).—The Hall effect was determined at $H = 2000$ oersteds in bismuth–antimony alloys. One typical series of results is : 100% antimony, +0·180; 75% antimony, +0·020; 50% antimony, −0·62; 25% antimony, −3·90; 0·0% antimony, −7·10. The significance of these data in the modern theory of metals is discussed.

***Cast Heat-Resistant Alloys of the 26% Chromium–20% Nickel Type.—I.** Howard S. Avery and Charles R. Wilks (*Amer. Soc. Metals Preprint* No. **16**, 1947, 50 pp.).—A. and W. present and discuss a large amount of data on the "HK" chromium–nickel–iron alloys (24–28% chromium, 18–22% nickel), including room-temp. mechanical properties, stress-rupture and creep properties in the temp. range 760°–1095° C., thermal expansion, resistance to carburization and hot-gas corrosion, and other properties. Most of the data refer to an alloy containing 0·30% carbon, but the effect of varying the carbon content over a wide range (0·10–1·41%) was investigated. Increase of carbon content lowered room-temp. ductility but increased hot strength without impairing hot ductility. The influence of nitrogen and other elements was also examined, but no marked effects were observed. A considerable spread in properties was found at 980° C., which is attributed to variations in the form and distribution of the carbides. A comparison was effected between the cast alloy (0·10% carbon) and a similar wrought alloy; the hot strength of the cast material was between those of the solution-treated and normalized wrought materials. The 0·30%-carbon cast alloy is considerably stronger. The cast alloy possesses good hot-gas corrosion-resistance and is suitable for carburizing service when containing a high carbon content and 2% silicon. At 1095° C. decarburization may be more serious than metal loss due to scaling. The metallography of the alloy is described and the effect of heat-treatment is examined. The alloy is compared with other similar chromium–nickel–iron alloys with which it is considered to compare favourably, having the best combination of all-round properties for service above 870° C.—R. W. R.

***The Cobalt–Chromium "J" Alloy at 1350° to 1800° F.** Nicholas J. Grant (*Amer. Soc. Metals Preprint* No. **17**, 1947, 27 pp.).—Room-temp. tensile tests and stress-rupture and hot-ductility tests in the temp. range 732°–1010° C. were carried out on hot investment cast test-pieces in a number of different cobalt–chromium–molybdenum alloys based on the original "Vitallium" composition. Casting conditions were such as to produce a coarse grain in the specimens (9–13 grains per 0·250 in. dia. cross-section). Of the compositions examined the best hot-strength properties were obtained with the alloy "J" (cobalt 60, chromium 23, molybdenum 6, nickel 6, tantalum 2, and carbon 0·30–1·02%). With a carbon content of 0·40%, the as-cast "J" alloy has an ultimate tensile strength of about 54 tons/in.^{2}, and an elongation of about 10%; the best high-temp. properties are developed with a carbon content of 0·76%, this composition showing a rupture life of about 500 hr. at 816° C. and a load of 13·4 tons/in.^{2} Hot ductility of the "J" alloy is not decreased by increasing the carbon content. The alloy exhibits greater stability than the simpler cobalt–chromium alloys. Optimum rupture properties in the temp. range 732°–1010° C. are obtained after prior ageing at 732° C. for a minimum of 5 hr.; ageing under stress is not advantageous. The "J" alloy is stronger than previously known cast cobalt–chromium alloys up to 927° C. and is equally strong at 1010° C.; at 732° C., it is stronger than any of the forged alloys up to 1000 hr., and, above 732° C., is very much stronger for all test times. The results of creep tests at 816° C. show that the "J" alloy is equal in performance to other similar cast alloys, although not as good as the nickel–chromium–cobalt–iron alloys. Addition of cerium (0·1–0·7%) reduces the rupture life of the "J" alloy and also that of the nickel–cobalt–chromium–iron alloy, *N*-155 (modified). Much information is also presented with regard to the effect of ageing treatment, variation of composition, &c., on the properties of some of the other alloys investigated.—R. W. R.

***Wrought Copper Alloys with High [4–5%] Silicon.** A. G. H. Andersen (*Metal Progress*, 1946, **50**, (5), 839–843).—A. reports the results of experiments on the mechanical properties of binary copper–silicon alloys containing 4–5%

silicon. 16-lb. ingots were cast, soaked, and drawn down to various degrees. The effects of degree of cold working and annealing on the hardness and tensile properties of the alloys were determined and are shown in graphs. The alloys have good resistance to stress-corrosion after relief annealing. Other outstanding characteristics are their good machinability and low permanent set after overloading.—N. B. V.

***The Thermal Expansion of the Gold–Copper Alloy $AuCu_3$.** E. A. Owen and Y. H. Liu (*Phil. Mag.*, 1947, [vii], **38**, (280), 354–360).—Cf. *Met. Abs.*, this vol., p. 233. The lattice spacing of the $AuCu_3$ alloy was measured at temp. between 18° and 620° C. and the results are tabulated. From room temp. to about 320° C. the parameter of the ordered lattice increases almost linearly with temp., the mean value of the coeff. of expansion over this range being $16{\cdot}5 \times 10^{-6}/°C$. The rate of expansion then increases as the transformation temp. is approached, and at 385° C. there is a sudden increase from $a = 3{\cdot}7641$ kX. to $a = 3{\cdot}7685$ kX. as the temp. is raised through the critical range. Above this temp. the alloy is in the disordered state, and at 390° C. the coeff. of expansion is approx. $18{\cdot}5 \times 10^{-6}/°C.$, and increases to about $22{\cdot}2 \times 10^{-6}/°C.$ at 600° C. Experiments show that provided the rate of change of temp. is sufficiently slow, the transformation occurs at the same temp. on heating as on cooling.—W. H.-R.

***Crystal Chemistry of Indium and Gallium in Alloys with Some Transition Elements [Nickel, Palladium, Platinum, Silver, and Copper].** E. Hellner and F. Laves (*Z. Naturforsch.*, 1947, [A], **2**, (3), 177–183).—To extend knowledge of the chemical behaviour of gallium and indium in alloys, the crystal structures, hitherto unknown, of twenty intermetallic phases of these elements with transition elements were determined. The types preferred are such as indicate, from a geometrical viewpoint (on account of the atomic-distance relations), the action of heteropolar forces. The results confirm the assumption of heteropolar binding tendencies, which in this system are to be regarded as the expression of an electronegative character of gallium and indium. There are a number of references and equilibrium diagrams for the systems nickel–gallium, nickel–indium, copper–indium, and silver–indium.—F. M.

Microporosity in Magnesium Alloy Castings. Herbert Dobkin (*Foundry*, 1946, **74**, (10), 98–101, 178, 180, 182; and (summary) *Metallurgia*, 1947, **36**, (213), 172).—D. discusses various theories for the occurrence of microporosity in magnesium alloys and makes recommendations for its minimization. Figures are given showing the effect of varying degrees of microporosity on the mechanical properties of Dowmetal C (9% aluminium, 2% zinc) and Dowmetal H (6% aluminium, 3% zinc).—R. W. R.

***Researches on the Preparation of the Binary Compounds of Molybdenum and of Tungsten by Electrolysis in the Fused State.** (Weiss). See p. 242.

***Investigations in the System Rhodium–Tin.** K. Schubert (*Z. Naturforsch.*, 1947, [A], **2**, (2), 120).—Concluding crystallographic investigations of the binary systems formed between the transition metals and the elements of the neighbouring Group 4 (H. Nowotny and K. Schubert, *Metallforschung*, 1947, **1**, 17, 23) the system rhodium–tin was investigated microscopically and by X-rays. Rh_2Sn forms a eutectic with the solid solution (lattice constant $a_w = 3{\cdot}85$ Å) of rhodium (tin). The homogeneous range of Rh_3Sn_2 goes from 56 to 59 wt.-% of rhodium. The structure of the phase is of the filled-up $B8$ type. Lattice constants of a specimen with 56 wt.-% of rhodium were $a = 4{\cdot}331$ Å, $c = 5{\cdot}542$ Å. From the phase Rh_3Sn_2 arises peritectic RhSn of type $B20$, with the parameters $a_w = 5{\cdot}122$ Å, $X_{Rh} = 0{\cdot}10$, $X_{Sn} = 0{\cdot}40$. $RhSn_2$ forms a eutectic with RhSn at about 34 wt.-% rhodium. $RhSn_2$ is analogous with $PdSn_2$. The peritectic compound from the approx. compound $RhSn_4$ forms a eutectic with tin.—F. M.

***The Positive Rectifying Photo-Electric Effect in Selenium [with Thallium and Mercury Additions].** B. T. Kolomietz (*Compt. rend.* (*Doklady*) *Acad. Sci. U.R.S.S.*, 1947, **55**, (3), 207–208).—[In English]. K. studied the effect of thallium and mercury additions on the mechanism of the rectifying photo-electric effect in selenium. It was found that both negative and positive photo-electric effects are in this case of the " hole " and not of the electron conductivity type.—V. K.

***Phase Relations in the System Sulphur–Silver and the Transitions in Silver Sulphide.** F. C. Kracek (*Trans. Amer. Geophys. Union*, 1946, **27**, 364–374; *C. Abs.*, 1946, **40**, 6357).—The system silver–sulphur was studied by differential thermal analysis in a pressure-tight apparatus. Heating and cooling curves were prepared.—J. L. T.

***The Reflectivity of Speculum Metal.** S. Tolansky and W. K. Donaldson (*J. Sci. Instruments*, 1947, **24**, (9), 248–249).—The reflectivities of electro-deposited speculum metals over the range 4500–6500 Å were measured, the conditions of deposition being adjusted to give copper–tin alloys containing 65, 55, and 45% copper, respectively. The reflectivity of the freshly polished alloy containing 55% copper varies from 63% at 4500 Å to 75% at 6500 Å. After keeping for 6 months in a damp atmosphere, the reflectivity decreases by 10% in the red region and by 2% in the blue region. Of the electro-deposited alloys, the 55% copper alloy had the highest reflectivity and greatest resistance to tarnishing. An alloy prepared by evaporation of a 55% copper alloy on to a glass base had a higher reflectivity varying from 68% at 4500 Å to 78% at 6500 Å. The composition of the actual evaporated mirror was not determined.—W. H.-R.

***Tellurides of Vanadium and Zirconium.** E. Montignie (*Bull. Soc. Chim.*, **1946**, 176; *C. Abs.*, 1946, **40**, 6014).—Vanadium pentoxide and tellurium dioxide react to give a solid solution of tellurium in a lower oxide of vanadium. Tellurium reacts with vanadium pentoxide to produce vanadium trioxide. No telluride of vanadium could be produced by heating tellurium and vanadium pentoxide in hydrogen. $TeZr_2$ resulted from heating zirconium tellurate in hydrogen at 500° C. It is a black compound insoluble in water, acids, and organic solvents. In hot conc. sulphuric acid it reacts, and then goes into solution on dilution. It dissolves in fused sodium carbonate, but not in hot 30% caustic potash. Zirconium dioxide results from heating it in air. A mixture of zirconium dioxide and tellurium in hydrogen at 500° C. did not yield definite compounds.

***Effect of Structure and Composition on the Mechanical Properties of Alloys.** Ya. B. Fridman (*Vestn. Inzhen. Tekhn.*, **1946**, (2), 44–50; *C. Abs.*, 1946, **40**, 6041).—[In Russian]. As the grain-size of a metal increases, the tensile strength declines, and thus when metals are tested by pull the plasticity and viscosity of large-grained metals seem greatly lowered. Since the resistance to shear is only slightly affected by grain-size, the brittleness of metals tested by shearing action is not observed. Only metals in a viscous state, such as aluminium-, copper-, and magnesium-base alloys, above certain temp. become less plastic as the concentration of solid solution increases; the plasticity and viscosity of metals which are in a brittle state increase as the concentration of solid solution rises, e.g. magnesium alloys when pulled and bent at 20° C. Some alloys which are not cold-brittle become so in the presence of a heterogeneous structure, e.g. aluminium alloys containing 8–10% magnesium; in these cases intercrystalline cracking is generally observed.—J. L. T.

†Mechanical Properties of Metals at Low Temperatures: A Survey. (Seigle and Brick). See p. 226.

***Tempering Effects and the Mechanical Equation of State.** (Fisher and MacGregor). See p. 226.

III.—STRUCTURE

(Metallography ; Macrography ; Crystal Structure.)

[For all abstracts on the constitution of alloy systems, including X-ray studies, see II.—Properties of Alloys.]

*****Superlattice Formation** [**in the Alloy $AuCu_3$**]. E. A. Owen and G. MacArthur Sim (*Phil. Mag.*, 1947, [vii], **38**, (280), 342–354).—Cf. *Met. Abs.*, this vol., p. 231. Measurements were made of the lattice spacings and of the widths of the X-ray diffraction lines from filings of the alloy $AuCu_3$ after different heat-treatments, and the bearing of the results on the theory of superlattice transformations is discussed. The mean value of the lattice parameter at 18° C. of $AuCu_3$ quenched from 500° C. in cold water is $3{\cdot}7452_5$ kX. On annealing at 350° C. the lattice spacing falls rapidly for about 3 hr. to a value which is nearly the final value of 3·7402 kX. obtained after prolonged annealing at this temp. Measurements of total intensity, max. intensity, and line width show that on annealing at 350° C. the amount of superlattice present increases at first rapidly and then continues to increase slowly even after long periods of annealing of the order 100 hr. The obtaining of an almost const. lattice spacing is thus not an indication that a superlattice change is complete. Measurements of the shapes of the profiles of superlattice lines are described, and the sizes and growth of nuclei are discussed.—W. H.-R.

*****Effect of Crystal Orientation on the Hot Oxidation of Iron and Copper.** Jacques Bénard and Jean Talbot (*Compt. rend.*, 1947, **225**, (9), 411–413).—The investigations previously carried out on the variation of the rate of oxidation in air at 850° C. of polycrystalline iron after various mechanical treatments (*Rev. Mét.*, 1947, **44**, (3/4), 82) were extended to copper. In the case of rolling, it was found that the rate of oxidation of iron and copper increases proportionately with the reduction in area. X-ray examination of the deformed metal showed that this variation is connected with the appearance of an orientated structure and is independent of the sub-division of the crystals and lattice disturbance. A study of the oxidation of large single crystals was required to interpret these facts. Single crystals of copper some 10 cm.^{2} in area were therefore prepared, their crystallographic orientations determined by Laue diagrams, and the isothermal oxidation–time curves at 900° C. plotted using a Chevenard thermo-balance. It was shown that the effect of the deformation of copper and polycrystalline iron on the susceptibility of these metals to oxidation finally results in the unequal rate of oxidation following the crystal oxidation. The origin of the anistropy thus revealed might be due to the difference between the true rates of oxidation of the metallic crystal faces or to unequal rates of diffusion of the elements of the reaction (metal and oxygen) across the oxide already formed on each of them. The second alternative appeared the more likely from previous published investigations, and was confirmed in the case of copper by a study of the orientation of the oxide crystals in the grains. A new fact discovered was that the oxidation–temp. curves show in the first few minutes a perfectly straight line portion before taking a parabolic form. The slope of this line represents the true rate of oxidation of the metal before it is retarded by the effect of diffusion.—J. H. W.

*****An Investigation Into the Structure of the Nickel Skeleton Catalyst** [Ni_2Al_3]. G. G. Urazov, L. M. Kefely, and S. S. Lelchuk (*Compt. rend.* (*Doklady*) *Acad. Sci. U.R.S.S.*, 1947, **55**, (8), 735–738).—[In English]. X-ray diffraction patterns were obtained from single crystals of Ni_2Al_3 before and after the removal from them of aluminium in alkaline solutions. It is shown that alkali-

treated crystals consist of a skeleton structure of Ni_2Al_3 in which minute particles of nickel are embedded.—V. K.

***The Crystal Structure at Room Temperature of Eight Forged Heat-Resisting Alloys.** J. Howard Kittel (*Tech. Notes, Nat. Advis. Cttee. Aeronautics*, 1946, (**1102**), 9 pp.; *C. Abs.*, 1946, **40**, 6388).—Eight "superalloys" for use at 1200° F. (649° C.) were studied: S816 (chromium 18, nickel 20, cobalt 46, molybdenum 4, tungsten 4, columbium 4, and iron 3·5%); S590 (chromium 19, nickel 19, cobalt 19, molybdenum 4, tungsten 4, columbium 4%, and iron balance); N155 (chromium 21, nickel 20, cobalt 20, molybdenum 3, tungsten 2, columbium 1%, and iron balance); Gamma Cb (chromium 15, nickel 24, molybdenum 4, columbium 2%, and iron balance); Hastelloy B (nickel 60 and molybdenum 27%); 16–25–6 (chromium 16, nickel 25, molybdenum 6%, and iron balance); 19–9 DL (chromium 19, nickel 9, molybdenum 1, tungsten 1·5, columbium 0·5, titanium 0·3%, and iron balance); and Nimonic 80 (nickel 74, chromium 21, titanium 2·5, and aluminium 0·6%). The predominant phase occurring in each alloy is a solid solution of the alloying elements in relatively large amounts, having a structure of the face-centred-cubic type. Alloys S816, S590, and Gamma Cb, which contain the largest amounts of columbium, showed diffraction lines from a second phase believed to be columbium carbide. With cobalt $K\alpha$ radiation, lattice constants were S816, 3·5733; S590, 3·5928; N155, 3·5867; Gamma Cb, 3·5932; Hastelloy B, 3·5915; 16–25–6, 3·5975; 19–9 DL, 3·5918; and Nimonic 80, 3·5583; the accuracy is $\pm$0·0005.

***Effect of Structure and Composition on the Mechanical Properties of Alloys.** (Fridman). See p. 232.

***Use of Coated Lenses for Metallography.** Edward Walden (*Metal Progress*, 1946, **50**, (5), 1097–1099).—W. presents comparison photomicrographs showing the advantages of fluoride-coated objective lenses over uncoated ones in the case of both steel and aluminium alloy. A coating of fluoride compounds (about 0·000006 in. thick) having a low index of refraction was applied to the lenses, without heat, using a high-vacuum technique. The main advantages of the coated lens are increased negative contrast, which helps to bring out detail in low-contrast samples, and reduced over-all glare, giving greater detail in dark areas of the photomicrograph.—N. B. V.

Room-Temperature Casting Resin for Metallographic Mounts. George L. Kehl and James S. Church (*Metal Progress*, 1946, **50**, (5), 1089–1090).—A resin for mounting microspecimens is described which does not necessitate the use of pressure or high temp. The resin is essentially a partially polymerized methyl methacrylate monomer that is allowed to harden and become completely polymerized after casting round the specimen. To accelerate polymerization, the mount is placed under an ultra-violet lamp and maintained at 120° F. (50° C.) for 2–3 hr. The preparation of the resin solution is described in detail.—N. B. V.

***Structure of Evaporated Films as Determined by Electron Diffraction and Electron Microscopy.** Henry Levinstein and Robley C. Williams (*J. Opt. Soc. Amer.*, 1947, **37**, (6), 520–521).—Summary of a paper presented to the Optical Society of America. For those who work with the optical, electrical, and thermal properties of thin films deposited *in vacuo*, an adequate visualization of their microstructure is important. Contrary to general belief, most films are discontinuous in internal structure and are far from smooth on the surface. The magnitude of the discontinuities and surface features discussed is of the order of 10–1000 Å. Electron-diffraction and electron-microscope studies of some 35 elements have been made. The results indicate that with respect to internal structure the films may be placed in three categories: (1) those which are amorphous, (2) those which have crystallites of a size such as to exhibit sharp diffraction rings and to be visible in the microscope, and (3)

those which have large crystallites and are preferentially oriented. Film structures in the three categories are functions of the m.p. of the element, and are affected by the thickness of the film. Particle size is found generally to increase as the film is made thicker, but this effect is enormously enhanced in going from film type (1) to (3). Some work has been done with replicas of the surfaces of films, and it is found that the degree of surface irregularity is roughly correlated with the internal irregularity.—J. L. T.

The Standardization of Crystal-Structure Models. —— (*J. Sci. Instruments*, 1947, **24**, (9), 249–250).—A report of the Crystal Structure Model Panel of the X-Ray Analysis Group of the Institute of Physics, recommending that common atoms and ions be represented by spheres of the following colours: H cream; C, Si black; O red; S yellow; N blue; P purple; halogens green; OH blue-green; H_2O orange; metals brown, grey, or gold. The models should be on scales such that 1 Å is represented by 1, 2·5, or 5 cm. according to the purpose of the model. Other suggestions are given for the construction and design of models.—W. H.-R.

***An Accurate Method of Adjustment of Bent Crystal Monochromator Slits for X-ray Low-Angle Scattering Studies.** J. B. Nelson (*J. Sci. Instruments*, 1947, **24**, (7), 193).—A method is described for the exact adjustment of X-ray monochromators of the bent quartz crystal type.—W. H.-R.

V.—POWDER METALLURGY

Metal-Powder Self-Lubricating Bearings. A. J. Langhammer (*Iron Steel Eng.*, 1947, **24**, (1), 93–95; discussion, 95–97).—A review of the advantages and applications of self-lubricating bearings made from powder compacts, particularly high-purity tin bronze. A case is reported of a bronze bearing withstanding an instantaneous load of 100,000 lb./in.^{2}—M. A. V.

The Metallurgy of Metal Powder. P. Erik Wretblad (*Tidsskr. Kjemi Bergvesen Met.*, 1946, **6**, (4), 45–53; *C. Abs.*, 1946, **40**, 6031).

Metal Powders and Powder Metallurgy. H. W. Greenwood (*Powder Metallurgy, Ltd., Publ.*, [**1947**], 23 pp.).—After comparing the general properties of powder-metallurgy products with those produced by other means (two tables are included giving the physical properties of fused and sintered copper, and sintered compacts), G. emphasizes the need for careful size specification. Variations in size affect the porosity of the pressing, the apparent density, flow factor, and voidage. The actual size is important because powder metallurgy is largely concerned with surface phenomena. Methods of preparation of powders (mechanical methods, atomizing, chemical methods, condensation methods, precipitation, and electrolytic deposition) are reviewed. Pressing and sintering are described. Special products of powder metallurgy, the spraying of metal powders, new developments to be expected, and limitations of the process are discussed.—J. L. T.

New Products and Processes: Atomized Metal Powders. —— (*Times Rev. Ind.*, 1947, **1**, (Feb.), 30).—See *Met. Abs.*, 1947, **14**, 52.—P. L.

Powder Metallurgy. Gregory J. Comstock (*Federal Sci. Progress*, 1947, **1**, (5), 34–35).—A non-technical account of powder-metallurgical processes, and the uses of powder-metal compacts.—R. W. R.

Progress in Powder Metallurgy. E. J. Sandford (*Metallurgia*, 1947, **37**, (218), 95–99).—A review of progress in powder production, pressing, and sintering. New applications include aluminium porous bushes and thrust washers. A *bibliography* of 47 references to the literature is appended.

—M. A. V.

Latest Trends in Powder Metallurgy.—I.—II. W. G. Cass (*Chem. Age*, 1947, **56**, (1436), 5–10; (1440), 199–202).—A brief historical note on the development of powder metallurgy, and a general review of modern patent and other literature.—M. A. V.

VI.—CORROSION AND RELATED PHENOMENA

Further Aspects of Stress-Corrosion Cracking in Brass. H. H. Symonds. E. Voce (*Sheet Metal Ind.*, 1947, **24**, (244), 1621).—S. and V. discuss the views advanced by J. C. Chaston (*Sheet Metal Ind.*, 1947, **24**, (243), 1395; *Met. Abs.*, this vol., p. 10).—R. Gr.

New Alloys [Chlorimet Series] for Severe Corrosion Services. M. G. Fontana (*Chem. Eng.*, 1946, (10), **53**, 114–115).—F. describes the Chlorimet series of alloys, high-nickel–molybdenum–chromium, and nickel–molybdenum alloys (about 97% nickel), suitable for handling all concentrations of sulphuric acid, hydrochloric acid, wet chlorine, sodium chloride, hot acetic acid, bleach solutions, &c. Compositions given are: Chlorimet 3: nickel 60, molybdenum 18, and chromium 18%; Chlorimet 2: nickel 63, and molybdenum 32%. Details of strength, heat-treatment, corrosion-resistance, &c., are listed. For resistance to abrasion, the cast nickel–molybdenum alloy can be age-hardened; the nickel–molybdenum–chromium alloy shows little tendency to age-harden. These alloys are produced only as castings, and their biggest uses are as pumps and valves.—P. L.

***Effect of Crystal Orientation on the Hot Oxidation of Iron and Copper.** (Bénard and Talbot). See p. 233.

***The Corrosion of Elektron AM503 Sheet in Chloride Solutions, and the Effect of Fluoride Additions and Concentration Variations.** C. J. Bushrod (*Magnesium Rev. and Abs.*, 1946, **6**, (4), 132–138).—An account of an investigation to ascertain whether chloride additions were permissible to welding fluxes of the "non-corrosive" type, and which were of fluoride base. Immersion tests were made in solutions varying from 10% KCl, 0% KF, to 10% KF, 0% KCl. Even with the lowest concentration of chloride examined. (8% KF, 2% KCl in water), severe local pitting occurred, and it was concluded that the composition of all-fluoride non-corrosive welding fluxes could not safely be modified to produce lower m.p. mixtures by the addition of small quantities of chlorides.—F. A. F.

***Weathering Effects on Magnesium Coatings.** Loring R. Williams and George W. Sears (*Light Metal Age*, 1947, **5**, (4), 10–11, 22).—Magnesium plates, chrome-pickled and coated with various proprietary protective coatings (exact nature not stated) were exposed for 14 months in Western Nevada, U.S.A. Adherence was found to be satisfactory, and corrosion-resistance good provided the primer was chosen to suit the top coat.—M. A. V.

Behaviour of Nickel–Copper Alloys in Sea Water. Herbert H. Uhlig (*Record Chem. Progress*, 1946, **7**, 56–58; *C. Abs.*, 1946, **40**, 6393).—A review, with 6 references.

***Test of Nickel-Plated Pipe in Corrosive Distillate Well.** B. B. Morton (*Corrosion*, 1947, **3**, (11), 592).—Nickel-plated, and unplated carbon-steel tubes were exposed in a distillate well. After approx. one year, the former were unaffected, and the latter markedly corroded.—M. A. V.

Accelerated Corrosion Testing of Protective and Decorative Coatings. R. R. Rogers (*Canad. Paint Varnish Mag.*, 1946, **20**, (8), 18–20; *C. Abs.*, 1946, **40**, 6397).—An address. Several pieces of apparatus are described which are designed to permit accelerated corrosion testing and the measurement of porosity and sheer hardness of coatings on metals.

The Agents, Basic Causes, Control, and Prevention of Corrosion. F. A. Prange (*Oil Gas J.*, 1946, **45**, (18), 88–93; *C. Abs.*, 1946, **40**, 6397).—A review.

Corrosiveness of Water to Metals. Thomas R. Camp (*J. New England Water Works Assoc.*, 1946, **60**, 188–216; *C. Abs.*, 1946, **40**, 6397).—The electrochemical theory of corrosion is developed for practical application. The theory is first studied as to corrosion reactions and the conditions upon which corrosiveness of a water depends. Several types of anodic reactions are given, with formulæ, as well as cathodic reactions. Thermodynamic equilibrium is also discussed and a formula given by which corrosiveness of any metal in aqueous solution can be determined. A very extensive table is given showing standard oxidation potentials at 25° C. of some half-cell reactions to be considered in the study of the corrosion of metals in water. Several examples of the application of the theory are given in detail. The formation and value of protective coatings are described briefly.

The Resistance of Metals to Scaling. Benjamin Lustman (*Metal Progress*, 1946, **50**, (5), 850–856, 860).—A review, prepared for the 1947 edition of the *Metals Handbook*. 24 references are given. An appendix deals with the dissociation pressures of oxides formed on various solid metals.—N. B. V.

Corrosion in Vertical Turbine Pumps. T. E. Larson (*Power Plant Eng.*, 1946, **50**, (9), 80–81, 109–110; *C. Abs.*, 1946, **40**, 6398).—Corrosion in deep-well pumps should be expected; it will be largely galvanic. Carbon dioxide is also a cause. Cathodic protection and protective coatings are discussed briefly. The use of acid to remove pump deposits is mentioned.

Corrosion of Constructional Materials by Sulphur and Sulphides. James R. West (*Chem. Eng.*, 1946, **53**, (10), 225–226, 228, 230, 232, 234, 236, 238).—Aluminium is not attacked by sulphur in liquid or vapour form. Aluminium containing sulphur-corrodible impurities is susceptible, however. Boiling sulphur has no effect on aluminium. Plain cast iron and mild steel may be used for solid and liquid sulphur up to 350°–400° F. (177°–204° C.), provided air is excluded from the liquid and moisture from the solid sulphur. The temp. limit is increased to 830° F. (443° C.) by metallizing the iron or steel with chromium or aluminium, and the ill effects of water are relieved by the addition of ammonium bicarbonate to the solid sulphur. Ceramics and fused silica are not attacked by sulphur, sulphides, and polysulphides at temp. below 300° F. (149° C.). Sulphur and sulphides have no appreciable effect on chromium. Copper is completely unfit; copper alloys are better, but leave much to be desired. Additions of tin, zinc, and manganese to copper reduce the corrosion rate. Lead is not suitable. Magnesium is good, but has a low m.p. Manganese resists the attack of sulphur up to 750° F. (399° C.). If free access of air is prevented, nickel and its alloys are quite resistant up to 575° F. (302° C.). The use of platinum is unlikely, because of its high cost, while silver and silver alloys are not suitable. Monel metal and nickel are satisfactory for the handling of sodium sulphide solutions.—P. L.

Special Materials Solved Corrosion Problems at Oak Ridge. P. J. Schrader and A. De Haan (*Chem. Eng.*, 1946, **53**, (11), 96–101).—The prevention of corrosion is a major problem in electromagnetic separation plant; units are cleaned periodically, incidentally recovering unresolved uranium. 18–8 stainless steel containing 2% molybdenum is used extensively for piping, but as the austenitic structure breaks down at 800°–1600° F. (427°–871° C.), ferrules are used instead of welding. Pyrex glass, Hastelloy, saran, and porcelain are used, while Tygon and Teflon are used for gaskets. Muffle furnaces are lined with high-nickel stainless steel for use with highly oxidizing atmospheres. The evaporation of nitric acid solutions is carried out in vessels lined with tantalum to a depth of 0·013 in.—P. L.

Chemical and Heat Resistance of Gasket Materials. H. H. Dunkle and E. C. Fetter (*Chem. Eng.*, 1946, **53**, (11), 102–109).—The governing factors are:

(1) the mechanical features of the flange, i.e. bolting, surface finish, &c.; (2) the operating conditions, i.e. pressure, cycle, temp., and corrosion. D. and F. enumerate gasket constructions in general use and touch briefly on their applications, describe ordinary gasket materials, give detailed information on heat and chemical resistance, discuss the selection of material, and review metallic and non-metallic gaskets. The following metals and alloys are referred to: lead, tin, aluminium, copper, brass, Monel metal, silver, platinum, ingot iron, low-carbon steel, and other steels.—P. L.

[Table of] Chemical Resistance of Constructional Metals and Non-Metals. —— (*Chem. Eng.*, 1946, **53**, (11), 120–150).—This table was compiled with the object of narrowing down the field of materials worth investigating for use under the stated conditions. It gives the resistance to corrosion of various materials to the following common and troublesome chemicals: acetic acid, alum, aluminium chloride, ammonium sulphate, benzol, bromine, calcium hypochlorite, carbon tetrachloride, chlorine, chromic acid, fatty acids, ferric chloride, hydrocarbons (aliphatic), hydrocarbons (aromatic), hydrochloric acid, hydrofluoric acid, nitric acid, oxalic acid, phenol, phosphoric acid, sodium chloride, caustic soda, and sulphuric acid.—P. L.

Hydrogen Peroxide: Structural Materials, Manufacture, and Uses. J. S. Reichert and R. H. Pete (*Chem. Eng.*, 1947, **54**, (4), 213–214, 216, 218, 220, 222, 224, 226, 228).—Success in manufacturing, shipping, and applying hydrogen peroxide solutions in commercial use depends largely on the selection of proper structural materials for processing equipment. Pure solutions are very stable, but decomposition is accelerated by very small amounts of catalysts, e.g. lead, manganese, iron, and copper. R. and P. discuss various structural materials, with specific reference to the optimum conditions of use and the requisite inhibitor to prevent catalysis.—P. L.

Influence of Metals on Processed Foods. Grafton D. Chase (*Crown*, 1946, **35**, (8), 17, 26–27; *C. Abs.*, 1946, **40**, 5499).—A review, dealing with the public-health aspect, the nutritional aspect, the causes of discoloration, and the effects of iron and copper. 13 references are given.

Disadvantage of Dissimilar Metals in Equipment. T. G. Hieronymus (*Corrosion*, 1946, **2**, 163–164; *C. Abs.*, 1946, **40**, 6397).—Designers of industrial equipment need to give more attention to avoidance of dissimilar metals which may set up galvanic cells. Several instances of such corrosion are cited.

VII.—PROTECTION

(Other than by Electrodeposition.)

Anodic Oxidation of Aluminium Alloys and the Possibilities of Its Application in Machine Building. N. D. Tomashov (*Vestn. Inzhen. Tekhn.*, **1946**, (2), 59–65; *C. Abs.*, 1946, **40**, 6005).—[In Russian]. The electrolytes used for anodic oxidation are divided roughly into 3 groups: (1) electrolytes which have no effect on the freshly formed oxide film (solutions of nitrates, bicarbonates, borates, phosphates, and chromates); (2) electrolytes which slightly dissolve the film (chromic, oxalic, and sulphuric acids, bisulphates, alums, and permanganates); (3) electrolytes which readily dissolve the film (alkali hydroxides, hydrochloric acid, and chlorides). The thickness and the density of the oxide film are largely determined by the electrolyte in which it is formed. Films of appreciable thickness (1–100 and in certain cases up to 600 μ) can be produced in electrolytes of group (2) by properly choosing the concentration, temp., c.d., nature of current (A.C. or D.C., potential, &c.), time of anodizing, &c. The effects of these factors, individually and combined, are discussed. Anodically oxidized aluminium has properties which make it desirable in the

construction of internal-combustion motors. For this purpose, oxidized films 50–500 μ thick are required. The films are porous to an extent variable within certain limits. The pores can be filled with chromates to impart corrosion-resistance. They can also be filled with pigments to colour the surface, with silver salt to photo-sensitize it, or with oil or colloidal graphite to impart anti-friction properties to the surface. The oxidized film adheres very strongly to the aluminium base. The alumina film is resistant to high temp., very hard, wear-resistant, its heat condition is established to be 0·001–0·003 cal./cm. sec., and its coeff. of heat reflection at 150°–200° C. is 80 compared with 100 for a black body. The advantages of using alumina films on pistons, cylinder heads, cylinder linings, bearings, and other parts are discussed.

***The Theory of the Formation of Protective Oxide Films on Metals.—III.** N. F. Mott (*Trans. Faraday Soc.*, 1947, **43**, (7), 429–434).—Cf. *Met. Abs.*, 1940, **7**, 297. Many metals when exposed to air have a compact oxide film formed and at sufficiently high temp. the rate of growth is given by $x = kt$, where $x =$ film thickness and $t =$ time of exposure. In some cases, $x = a \log (1 + bt)$ is a better representation. M. puts forward a hypothesis to explain the formation of protective films: (1) The work function is small enough to allow the thermionic emission of electrons from the metal into the conductive levels of the oxide. If oxygen is adsorbed, surface oxide and oxide ions are formed, and a strong electric field is set up in the oxide. (2) Solution of metal ions in the oxide occurs at temp. considered too small for any passage of metal by diffusion. But under these very strong fields, migration of ions can take place. A theory based on these assumptions gives a limiting thickness which increases rapidly with temp. up to a certain critical temp., above which a parabolic law should hold.—P. L.

***Mechanical Properties of Chromium Diffusion Coatings.** N. S. Gorbunov, I. D. Yudin, and N. A. Izgaryshev (*Compt. rend.* (*Doklady*) *Acad. Sci. U.R.S.S.*, 1947, **55**, (5), 415–417).—[In English]. Micro-hardness of chromium diffusion coatings was measured on pure iron, steel, and cast iron after a preliminary 6-hr. treatment at 1000° C. for iron and steel, and 900° C. for cast iron. The results show that micro-hardness increases rapidly with an increasing carbon content, ranging from a value of 200 for pure iron to 1900 for cast iron.—V. K.

Continuous Hot Galvanizing of Strip. E. A. Matteson (*Iron Steel Eng.*, 1947, **24**, (3), 61–62; discussion, 63–66).—A brief review of modern continuous hot-galvanizing plants and processes.—M. A. V.

***Regalvanizing of Welded Joints.** George H. Ohmer (*Corrosion*, 1947, **3**, (11), 580–584).—Welded joints were regalvanized by "tinning" the weld with a low-m.p. alloy. A temp. of 600° F. (316° C.) is required, and the residual heat of the weld may be used. Bending and tensile tests on regalvanized welds, and on welds sprayed with zinc metal showed the former to be superior; there was no tendency to flake off, and no embrittling effect. Photomicrographs showed the coating to be a continuous layer, free from holes and fissures, and no corrosion was found after a 141-day salt-spray test.—M. A. V.

Metal Conservation in Europe: Progress of Phosphating. —— (*Metallurgia*, 1947, **37**, (218), 105–106).—A review of war-time developments in phosphating technique in Germany, Italy, and Russia.—M. A. V.

Metal Spraying and Industrial Economy. H. W. Greenwood (*Metallurgia*, 1947, **37**, (218), 60).—A review of the uses of sprayed coatings, particularly of zinc, and of polythene.—M. A. V.

Improvements in [Hot-Dip] Tinning. Howard C. Rodgers (*Iron Steel Eng.*, 1947, **24**, (1), 65–66).—The hot-dip tinning process for cold-rolled steel strip has been improved by the introduction of vacuum feeding and electrolytic pickling.—M. A. V.

The "Protecta-Tin" Treatment of Tinplate. —— (*Tin*, **1947**, (Dec.), 3–5).—A description is given of a method of producing a thin oxide film on tinplate to prevent the discoloration of cans by sulphur-containing foods, and of an improvement on this process which resulted in the tinplate being protected against rust also.—P. L.

Discussion of [E. J. Dunn's] Paper : Chemical Reaction in Metal Protective Paints. W. Beck (*Corrosion*, 1947, **3**, (11), 593).—Cf. *ibid.*, 1947, **3**, (8), 374; *Met. Abs.*, this vol., p. 156. Dunn's experimental results are confirmed.
—M. A. V.

Corrosion Control of Metal Structures by Cathodic Protection. M. C. Schwartz (*Proc. 8th Ann. Short Course Water Sewerage Plant Supts. and Operators, 1945, Louisiana State Univ., Eng. Exper. Sta., Bull. Ser.*, 1946, (**8**), 63–66; *C. Abs.*, 1946, **40**, 5001).—A review of the theory and its application to tanks and pipe-lines.

Cathodic Protection of Pipe-Lines [Use of Magnesium Anodes]. H. Seymour (*Min. Mag.*, 1947, **76**, (6), 339–340).—Corrosion of metal surfaces in the presence of moisture is for the most part electrolytic, and may be greatly reduced or prevented entirely by the use of an expendable and replaceable anode. A proper alloy composition of the anode and a suitable backfill surrounding it are essential to electrical efficiency, while the c.d. is an important factor. The specification range of suitable magnesium alloys is: aluminium 5·3–6·7, manganese (minimum) 0·18, zinc 2·15–3·5, silicon (max.) 0·3, copper (max.) 0·05, nickel (max.) 0·003, iron (max.) 0·003, other impurities (max.) 0·3%, magnesium remainder. A review of the value of magnesium in cathodic installations is given.—P. L.

Location and Selection of Anode Systems for Cathodic-Protection Units. D. B. Good (*Corrosion*, 1947, **3**, (11), 539–548).—In locating anodes for the cathodic protection of pipe-lines, soil resistivity should be measured and taken into account. This may be measured by the "four-bar" method, with a megger. Curves are presented, from which the most economical length of anode from soil of given resistivity may be estimated on a cost basis.—M. A. V.

Electrical Instruments and Measurements in Cathodic Protection. J. M. Pearson (*Corrosion*, 1947, **3**, (11), 549–566).—The characteristics of instruments of the D'Arsonval type, electronic voltmeters, and potentiometers are reviewed, and methods of measuring electrode potentials of corroding metals, and polarization, are described. The usefulness of test data is briefly discussed.
—M. A. V.

Cathodic Protection of Hot-Water Tanks. J. M. Bialosky (*Corrosion*, 1947, **3**, (11), 585–591; discussion, 591).—A general review of theory.
—M. A. V.

VIII.—ELECTRODEPOSITION

Value of Industrial Chromium Plating of Textile Equipment. Wm. F. Walton (*Textile Age*, 1946, **10**, (9), 38, 40, 42–44; *C. Abs.*, 1946, **40**, 6822).—The wear-resistance of a plated surface varies in accordance with the thickness of the chromium applied, as well as the methods by which it is applied. Chromium plating may prolong the life of a particular part of textile equipment as much as tenfold. Some chromium-plated textile machine parts are illustrated.

***Gold-Film Electrodes for High-Frequency Quartz Plates.** R. A. Spears (*J. Brit. Inst. Radio Eng.*, 1946, **6**, 50–62; *C. Abs.*, 1946, **40**, 5649).—A plate of quartz crystal of any vibration frequency can be modified to some required frequency by depositing gold films on its faces. It is shown that the number of cycles by which a plate frequency can be altered is proportional to the duration of the sputtering or electroplating process of depositing the films.

Methods of preparing the films and of mounting the coated crystals are described.

***The Anodic Formation of a Peroxide of Protoactinium.** M. Haïssinsky (*J. Chim. Phys.*, 1946, **43**, 66–72; *C. Abs.*, 1946, **40**, 6006).—Protoactinium is deposited anodically on a lead dioxide-covered platinum anode from solution in *N*-sulphuric acid when a c.d. of 8 to 15 m.amp./cm.^{2} is used. The solution contained 10^{-5} g./ml. of protoactinium. It can be separated from zirconium in this way. The deposit is removed by treatment with conc. nitric acid and hydrogen peroxide; the protoactinium is then separated from the lead by precipitating with sodium hydroxide. From ammonium carbonate-containing solutions at a *p*H of 7·5–8·2, protoactinium is also deposited anodically on electrodes of platinium, lead dioxide, or nickel oxide; the deposition is best on the peroxides. The c.d. used was 3–10 m.amp./cm.^{2} The formula of the deposit was not determined, but Pa_2O_6 is suggested. The reverse potential of the peroxide on a lead dioxide electrode in acid solution varies between 1·54 and 1·70 V.

Plating-Bath Voltage. G. W. Croninger and J. B. Mohler (*Iron Age*, 1947, **160**, (18), 66–68).—C. and M. tabulate the concentration, resistivity, and density of a number of common plating baths, and explain the use of these data for calculating plating-bath voltage, particularly when using high c.d. baths. The resistivity figures show that high voltages may be required for some plating applications and also indicate the changes in conditions that will reduce the voltage required.—J. H. W.

Some Chemical Hazards in the Electrical Industry. C. P. Fagan (*J. Proc. Roy. Inst. Chem.*, **1947**, (III), 124–126; and *Engineer*, 1947, **184**, (4775), 111). —Summary of a lecture to the Sheffield, South Yorkshire, and North Midlands Section of the Royal Institute of Chemistry. F. deals with the hazards arising from electroplating baths, which include cyanide poisoning from vapour and solutions, "nickel itch" from splashing nickel solutions on unprotected skin, and the effect on eyes and nose of chromic acid spray.
—J. B. C.

Treatment of Cyanide and Acid Plating Wastes. Nicholas Herda (*Sewage Works J.*, 1946, **18**, 499–502; *C. Abs.*, 1946, **40**, 5648).—Acid wastes are neutralized with lime, flocculated, and settled, calcium sulphate precipitating out. Chromate and dichromate wastes from "Alroking" (oxidation of aluminium in acid and alkaline dichromate solutions) are treated with ferrous sulphate to reduce the chromium, and lime to precipitate the iron and chromium. The required dosage of ferrous sulphate is determined as follows: to 100 ml. of the sample add 2 ml. sulphuric acid and 10 or more ml. 0·01-*N*-ferrous sulphate, allow to stand for 5 min., and back-titrate with 0·01-*N*-potassium permanganate. 1 ml. of ferrous sulphate solution is equivalent to 3·26 p.p.m. chromic oxide. 8 to 9 lb. ferrous sulphate applied for each lb. of chromic oxide gave a reduction of 99% chromic oxide. From 1 to 2 lb. of lime were added per lb. of sulphuric acid as determined by titration. Cyanide concentration in wastes was determined as follows: to 100 ml. of the filtered sample add 2 ml. of 10% potassium iodide and 5 ml. of ammonium hydroxide, shake, and titrate with 0·1-*N*-silver nitrate to first yellow colour. 1 ml. silver nitrate solution is equivalent to 52·03 p.p.m. cyanide. Use 0·01- and 0·001-*N*-silver nitrate for 5–50 p.p.m. and less than 5 p.p.m. cyanide concentrations, respectively. The normal wastes containing about 75 p.p.m. cyanide are placed in sealed reaction tanks and treated with 14 lb. of sulphuric acid for each lb. of cyanide, thereby reducing the *p*H to 3, after which the acidified waste is aerated for 6–10 hr. The fumes are exhausted through a 40-ft. stack with 5000 ft.^{3}/min. of air. The final effluent contains 1 p.p.m. cyanide.

IX.—ELECTROMETALLURGY AND ELECTROCHEMISTRY
(Other than Electrodeposition.)

***Photogalvanic Processes on a Gold Electrode.** V. I. Veselovsky (*Zhur. Fiz. Khim.*, 1946, **20**, 269–296; *C. Abs.*, 1946, **40**, 5990).—[In Russian]. A gold wire 1 mm. dia. was immersed in an electrolyte in a silica-glass capillary. It was anodically polarized by means of a similar gold electrode in a similar capillary; and its potential, V, was determined with respect to a platinum electrode, previously charged with hydrogen, in a third capillary. The gold wire was illuminated for 0·5–1 sec. and the change, ΔV, of its potential was measured with a string galvanometer. Experiments were carried out in electrolytes of different concentrations, with light of different intensity and wave-length, and with varying initial polarization, V. A semi-empirical equation connecting these quantities is deduced, and confirmed by the experimental results. —J. L. T.

Electrolytic Lithium: Report on a German Method. —— (*Chem. Age*, 1947, **56**, (1436), 19).—A digest of F.I.A.T. Final Report No. 786.—M. A. V.

***Researches on the Preparation of the Binary Compounds of Molybdenum and of Tungsten by Electrolysis in the Fused State.** G. Weiss (*Ann. Chim.*, 1946, [xii], **1**, (4), 446–525).—The work is an application of the researches of Andrieux, demonstrating the importance of secondary reactions in a fused electrolytic bath as a means of synthesizing binary compounds. Of metallurgical interest is the preparation of pure antimony by the reduction of its compounds dissolved in borax. Attention is directed to the possibility of introducing metallic additions in solution in the bath not only as oxides or halides but also as other compounds, e.g. sulphides. The preparation of molybdenum and tungsten alloys with antimony is studied, and it is established that their electrolytic preparation presents no difficulty. The existence of definite compounds Fe_2W and Fe_3W_2 in the iron–tungsten system is demonstrated. By simultaneous reduction of tungstic acid and the appropriate metallic oxide in a bath containing sodium, calcium, or lithium borate and fluoride, alloys of tungsten with chromium, vanadium, and titanium were prepared, but were in all cases contaminated with boron. Similar attempts to prepare alloys of tungsten with manganese and cerium produced mixtures of manganese or cerium boride with tungsten boride. In all these cases, therefore, boric anhydride must be replaced by a less reducible oxide as a solvent for the bath. The existence of a new carbide of iron with a Curie point at 245° C. is suggested in the section dealing with the electrolytic preparation of metallic carbides.—F. M.

***Electrolytic Polarization. I.—The Overpotential of Hydrogen on Some Less Common Metals at High Current Densities. Influence of Current Density and Time.** J. O. M. Bockris (*Trans. Faraday Soc.*, 1947, **43**, (7), 417–429).—The dependence of hydrogen overpotential on c.d. has been reported frequently, but a large proportion of the work has been carried out at low c.d. Until recently, none of the work at high c.d. had been free from serious objection. The work of Hickling and Salt is described, who used an improved form of the commutator method, in which polarization can be interrupted at any desired frequency; two criticisms of the method are made, and the apparatus is described. The variation with time was of two types: (1) showing an increase towards a max. value, after which the overpotential was approx. const. or decreased; (2) showing an initial increase, then a steady value, followed by an indefinite increase. The variation with c.d. was investigated. Low-m.p. metals have high, and high-m.p. metals have low overpotential (except smooth platinum). The general shape of the overpotential–log c.d. curve indicates either that (1) the Tafel equation applies over the whole c.d. range,

(2) there are negative deviations from the Tafel equation, or (3) the cathode potential reaches a specific const. value at high c.d., characteristic of each metal. A general discussion of the results is given. Values of overpotential at a given c.d. tend to show that overpotential is a function related to the work function of the metal.—P. L.

Electrometallurgy in Canada. J. L. Balleny (*Elect. Eng.*, 1947, **66**, (8), 774–778).—The development of hydro-electric power in Canada has resulted in many processes being developed or adapted to use electricity, and the changes are surveyed. Fuel-combustion heat is being replaced by electric heat for such processes as annealing and wire patenting and more electric power is being used in induction heating for forging and hardening, the regulation of smelting furnaces, and electric arc furnaces. Electrical heating has allowed short-time cycles and automatic operation, and has provided uniform results consistently.—J. B. C.

XI.—ANALYSIS

***Identification by a Micro-Crystalline Method of Very Small Amounts of Beryllium in the Metallic State.** Georges Denigès (*Compt. rend.*, 1947, **225**, (12), 474–476).—If 1–2 mg. of an alloy containing Be is treated with a drop of H_2SO_4 (1 : 3) on a watch-glass, action begins immediately and soon becomes violent, magnificent micro-crystals of $BeSO_4.4H_2O$ of the tetragonal type being formed without further evaporation of the liquid and even if the rest of the alloy is unattacked. D. further describes this test, gives the modifications required for identifying very low concentrations of Be, and discusses how the test can be incorporated with the Behrens test (formation of double oxalate of Be and K).—J. H. W.

***The Separation of Columbium and Tantalum from Titanium.** V. A. Oshman (*Zavod. Lab.*, 1946, **12**, 154–157; *C. Abs.*, 1946, **40**, 5660).—[In Russian]. Treat 0·2–2·0 g. of the sample with HF and H_2SO_4 to remove SiO_2, fuse the dry residue with $K_2S_2O_7$, extract with a mixture consisting of 10 ml. of conc. HCl, 4 ml. of 30% H_2O_2, and 36 ml. of water, heat slightly to facilitate the extraction, cool, and filter. (The precipitate may contain quartz, SnO_2, $BaSO_4$, and Zr.) Use a 300–500 ml. separating funnel connected by means of rubber tubing to a test tube for the reduction process. Before the reduction, fill the test tube with slightly acidified water, close the stop-cock, place approx. 200 ml. of amalgam in the funnel, and add the solution to be reduced. Expel the air from the reductor by means of CO_2, stopper the reductor, and shake it thoroughly (CO_2 in the reductor is necessary not only to prevent re-oxidation of Ti, but also to create a slight vacuum formed by the solution of some CO_2 in the liquid). After 1–2 min. the orange colour due to Ti disappears, the colour of $FeCl_3$ vanishes instantly, and the solution becomes colourless. Shake for 8–10 min. First an intensive violet colour of Ti^{+++} appears, then a greenish tint of reduced Cb. Transfer the amalgam from the reductor to the test tube, transfer the solution rapidly to a beaker, wash the funnel and stopper, add boiling water to 500 ml., boil for 20 min., add macerated paper, and filter immediately through an 11-cm. ashless filter. Wash the filter with hot, 4% HCl until no reaction for SO_4^{--} in the wash water is obtained, and ignite the filter with the precipitate to const. weight. Fuse the residue (containing several mg. of TiO_2 and, sometimes, Zr) with 3 g. of $K_2S_2O_7$ extract in 20 ml. of $9N$-H_2SO_4 in the presence of 3 ml. of H_2O_2, bring the vol. to 50 ml., and determine Ti colorimetrically. Add to the solution 10 ml. of 20% $(NH_4)_2HPO_4$, let stand for 2 hr. at 60° C., wash the precipitate of $Zr_3(PO_4)_4$,

first with 5% H_2SO_4 containing H_2O_2, then with 4% NH_4NO_3, ignite, and weigh the residue as ZrP_2O_7. Subtract the sum $TiO_2 + ZrO_2$ from the original weight of the precipitate of the impure earth oxides and determine the percentage content of the sum of the earth oxides by the usual method. Analyses of synthetic mixtures of Cb_2O_5 and Ta_2O_5 gave good results. Separation of Ti from Ta by a single reduction was somewhat poorer than that from Cb, but the final results were satisfactory. The method can be used also for samples containing small quantities of Zr. In the presence of considerable quantities of Ti and Zr, the results were less satisfactory, owing to the incomplete separation of Cb. The method was used for the analysis of concentrates containing up to 80% of TiO_2 and 10% of $Cb_2O_5 + Ta_2O_5$.

***Contribution to the Chemical Analysis of Indium.** Georges Denigès (*Compt. rend.*, 1947, **225**, (8), 369–371).—D. describes four microchemical or spot tests to identify small amounts of In in alloys, depending on the almost immediate formation of the chloride, nitrate, sulphate, or iodate of tervalent In. Less than 50 mg. of the metal is sufficient to carry out all these tests.
—J. H. W.

Some Applications of Inorganic Chromatography [—**II**]. G. Robinson (*Metallurgia*, 1947, **37**, (218), 107–108).—Cf. *Met. Abs.*, this vol., p. 195. It is suggested that it might be possible to separate Na and K chromatographically by using violuric acid for Na and 5-oxo-4-oximino-3-phenyliso-oxazoline (yellow band) for K. Suitable reagents are given for separating other metallic mixtures. New possibilities reviewed include the separation of organometallic complexes dissolved in organic liquids, the use of impregnated filter papers for chromatographic quantitative spot tests, and the application of partition chromatography to metallic complexes.—M. A. V.

***The Spectrographic Estimation of Aluminium in Metallic Oxide Residues : Application to the Determination of Oxide in Special Steels.** René Castro and J. M. Pheline (*Compt. rend.*, 1947, **225**, (15), 633–635).—The determination of O_2 in steels by the introduction of Al and the subsequent determination of the Al_2O_3 is relatively simple in the case of ordinary steels, but is greatly complicated in the case of alloy steels, which contain chemically inert constituents (carbides, nitrides, &c.) that are separated with the Al_2O_3. C. and P. describe the emission spectro-analysis method of determining small quantities of aluminium oxide in metallic residues, and the application of this method, which is rapid and reliable, to the determination of O_2 in alloy steels.—J. H. W.

***A Point-to-Plane Arc-ing Technique for the Spectrographic Analysis of Monel.** C. J. Neuhaus and Paul E. Lighty (*J. Opt. Soc. Amer.*, 1947, **37**, (6), 519).—Summary of a paper presented to the Optical Society of America. D.C. arc spectra between a Cu wire anode held in water-cooled clamps and the surface of a Monel metal sample, using 10 amp., are recorded for the analysis of Mn, Si, Al, and traces of Cr and Pb with a single exposure. The standard deviations from duplicate spectra range from 1·7% for Cr to 6·5% for Pb in routine testing. The summary gives the wave-lengths used and sufficient details.—E. van S.

***The Effect of Alkali and Alkaline-Earth Salts on the Spectrographic Determination of Strontium.** E. Fast and J. Rud Nielsen (*J. Opt. Soc. Amer.*, 1947, **37**, (8), 614–622).—A high-voltage A.C. arc carrying about 2 amp. was supplied from a 2500-V. transformer and fitted with water-cooled holders for graphite electrodes. Mixtures of dried chlorides of the metals tested were mixed with an equal weight, or more, of graphite dust and placed in the cup-shaped lower electrode. Titanium was added as internal-standard element, and in a series of tests in which the Sr : Ti ratio was kept const., the intensities of one Sr line and two Ti lines in the ultra-violet were measured. Besides varying the proportion of NaCl, KCl, $CaCl_2$, $BaCl_2$, or $MgCl_2$, the intensity ratios were followed for 10–20 min. from the beginning of arc-ing in order

to test the efficacy of various spectroscopic buffers. The results are almost completely inexplicable; some salts enhance the apparent Sr content of the mixtures by an increasing amount as more of the buffer is added, but usually not steadily, and to an extent which is modified by the presence of any third alkali metal in considerable concentrations.—E. VAN S.

***A Method for Micro-Spectrography of Metals.** Ford R. Bryan and George A. Nahstoll (*J. Opt. Soc. Amer.*, 1947, **37**, (5), 311–316).—A spark 1 mm. long is made to traverse slowly a strip about 0·04 mm. wide of the polished surface of a metallic sample. A binocular microscope is adapted so that one objective is replaced by a quartz capillary tube extending almost to the focal point, the corresponding eyepiece being replaced by an insulating lead for the high voltage. The output from a 5000-V. transformer is rectified and passed to the spark gap through a valve control circuit of unusual type. A synchronous motor is used to rotate the microscope stage so that the spark traverses at a few mm./hr., and long exposures are required. Rapid plates (Kodak Eastman 103) and a high-contrast developer should be used as the spark is rather faint, but it can sometimes be used to analyse the constituents of a heterogeneous metal.—E. VAN S.

†Continental War-Time Developments in Spectroscopic Technique. Ernest H. S. van Someren (*J. Sci. Instruments*, 1947, **24**, (9), 225–230).—A review of Continental work, with special emphasis on work unlike that carried out in England. The paper contains numerous references to spectroscopic analysis of alloys, and is divided under the following headings: (1) apparatus, (2) light sources, (3) technique, (4) methods, and (5) scope. A *bibliography* of 44 original papers is included. The paper deals mainly with branches of the subject of interest to the author personally, and does not claim to be a complete review, but much interesting material is included.—W. H.-R.

X-Ray Diffraction Index for the Identification of Materials. A. J. C. Wilson (*J. Sci. Instruments*, 1947, **2**, (11), 304–305).—A note describing the information which it is desired to include in the X-ray diffraction index of the Joint Committee on Chemical Analysis by X-Ray Diffraction Methods. A specimen card is reproduced.—W. H.-R.

XII.—LABORATORY APPARATUS, INSTRUMENTS, &c.

(See also " Testing " and " Temperature Measurement and Control ".)

***Improvements in Microscope Illumination.** James R. Benford (*J. Opt. Soc. Amer.*, 1947, **37**, (8), 642–647).—For metallurgical microscopy, the efficiency of the glass-plate type of vertical illuminator has been increased by a factor of $\times$ 2·5 by filming one side of the glass with TiO_2 and the other with MgF_2; the second film is necessary to eliminate a faint double image due to internal reflection in the plate itself. A vertical illuminator, with annular oblique illumination to give " dark field " effects, of improved construction has been made, in which the objective is held in its tube by a cylinder of transparent plastic, moulded to the correct form. This illuminator can also be used for vertical illumination in the usual way. The use of the new ZrO_2 enclosed arc lamps for photomicrography is discussed, but not strongly recommended. For intensity control when a high-power light source is used for photomicrography, grey filters of Inconel deposited on glass are recommended, as being a truly neutral grey.—E. VAN S.

The Electron Microscope. James Hillier (*Indust. Radiography Non-Destructive Test.*, 1947, **6**, (1), 25, 28–31).—A report of the design, technique, and applications of the electron microscope. A useful magnification of 100,000 dia. may be obtained, revealing structures varying in size from 20,000 to 10 Å.

The instrument may be used to study (1) structure of materials having some degree of organization, e.g. fibres and vulcanized rubber, (2) chemical processes, e.g. catalytic changes, (3) particle sizes and shapes, e.g. of metal powders in sintering processes. The method is not directly practicable to cut sections, but indirectly it may be utilized by making a replica of the surface. The application of this technique to metals is described.—L. M.

†**Some Aspects of Instrumental Physics in France (1939–1946).** G. A. Boutry (*J. Sci. Instruments*, 1947, **24**, (11), 281–295).—A review of some physical work carried out in France from 1939 to 1946. Contrary to general belief, a considerable amount of work was carried out during the war. The following items are of direct metallurgical interest: (1) improvements in microscope objectives, (2) improvements in X-ray diffraction technique, including new types of monochromatizors, and (3) improved types of electron microscope. Some of the other items are of indirect interest to metallurgists, and references to 28 original papers are given.—W. H.-R.

A Practical Furnace for Vacuum Melting. A. U. Seybolt (*Metal Progress*, 1946, **50**, (5), 1102–1106).—S. describes in detail the construction and operation of a furnace which has proved very satisfactory for melting and casting $3\frac{1}{2}$-lb. ingots of high-nickel alloys. The furnace is heated by a 20-kW. Ajax–Northrup spark-gap H.-F. converter, and the lowest pressure obtainable in operation is in the range of a few microns.—N. B. V.

***A Furnace for High-Temperature X-Ray Powder Cameras.** T. C. Alcock, H. S. Peiser, J. S. Pont, and H. T. S. Swallow (*J. Sci. Instruments*, 1947, **24**, (11), 297–298).—A small radiation furnace is described for use in a high-temp. vacuum camera of the Owen type. The furnace winding is of tungsten wire contained inside two sets of hemispherical radiation screens made of platinum–4% rhodium alloy. The radiation screens are good reflectors, and prevent loss of heat. A temp. of about 900° C. can be obtained, but it is doubtful whether temp. above 1000° C. can be reached without appreciable vaporization of the tungsten.—W. H.-R.

***A Twelve-Channel Recorder for Use with Resistance Strain-Gauges.** A. Watson (*J. Sci. Instruments*, 1947, **24**, (9), 239–242).—Electric circuits are described for the simultaneous recording of resistance changes from twelve separate groups of resistance strain-gauges.—W. H.-R.

Recent Developments in Calculating Machines. D. R. Hartree (*J. Sci. Instruments*, 1947, **24**, (7), 172–176).—Based on a lecture delivered to the Manchester and District Branch of the Institute of Physics.—W. H.-R.

***Neutral-Density Filters of Chromel A.** Mary Banning (*J. Opt. Soc. Amer.*, 1947, **37**, (9), 686–687).—Films of Chromel A (80% chromium, 20% nickel) can be deposited by evaporation from a Chromel wire heated by a tungsten coil at a pressure of 10^{-4} mm. mercury. Densities of 0·1 to nearly 2·0 can be produced from a single film, and these have the advantage of a const. absorption over the range 2400 to 15,000 Å. Chromium itself requires a higher temp. for evaporation, and the density decreases in the infra-red; the films of both metals are remarkably hard.—E. van S.

***Modulation of the Resonance Lines in a Cæsium Arc.** J. M. Frank, W. S. Huxford, and W. R. Wilson (*J. Opt. Soc. Amer.*, 1947, **37**, (9), 718–725).—Totally enclosed cæsium-vapour medium-pressure lamps have been developed for infra-red signalling purposes and they can be run from a 100-V. D.C. supply with a superimposed A.C. supply. With 80% current modulation, the light modulation ranges from 70 to 50% according to the frequency in the range 100 c./s. to 20 kc./s. The static and dynamic characteristics of the arc are described.—E. van S.

XIII.—PHYSICAL AND MECHANICAL TESTING, INSPECTION, AND RADIOLOGY

***A Micro-Hardness Tester.** H. Lloyd and R. Jeffrey (*J. Sci. Instruments*, 1947, **24**, (7), 186–189).—The hardness tester described is based on the Vickers pyramid hardness machine. The indenter carrying a standard pyramid diamond is designed to fit a microscope nose-piece, in place of the objective, so that the indentation can be made at an exact spot which has been chosen by previous visual examination. A calibrated spring takes the load, which is usually 50 g., and electrical contacts are arranged so that an indicator lamp goes out when the load is applied. The instrument is valuable for detecting local variations in hardness at different points on the surface of a specimen. When, however, tests are made on uniform materials, it is found that the hardness numbers calculated from indentations under a 50-g. load do not always agree with those under a standard 10-kg. load. The instrument must therefore not be used for absolute hardness determinations until the particular alloy concerned has been examined in detail under both normal and light loads.—W. H.-R.

How to Construct a Stress–Strain Diagram by Hardness Measurements. N. N. Davidenkov (*Metallurgia*, 1947, **37**, (218), 102–104).—Translated from *Zhur. Tekhn. Fiziki*, 1943, **13**, (7/8), 389–393; see *Met. Abs.*, 1945, **12**, 59. —M. A. V.

Limitation of Hardenability Indexes. Wm. Wilson, Jr. (*Frontier*, 1946, **9**, (1), 3–5; *C. Abs.*, 1946, **40**, 5614).—A summary of limitations, including a discussion of the Grossmann calculated hardenability and the Jominy hardenability bar. Tables show factors for (1) Grossmann hardenability calculation, and (2) Bainitic hardenability for various metals and non-metals. 17 references are given.

***A Gauge for Measuring Compression Force.** P. H. Rinkel (*J. Sci. Instruments*, 1947, **24**, (11), 298–299).—In this instrument, a test body is placed together with the gauge so that both are subjected to a compressive force in a press or vice. The amount of force can then be read on the gauge.—W. H.-R.

Screw-Driven Creep-Rupture Testing Machine. M. J. Manjoine (*Metal Progress*, 1946, **50**, (5), 1100–1101).—The machine described represents an improvement over that of White, Clark, and Hildorf (*ibid.*, 1938, **33**, 266) for carrying out rapid high-temp. tests on metals. The new device has no weights, requires no extensometer, and automatically draws a creep curve for each specimen tested. Lever arms and weights are eliminated by the use of a motor-driven screw-jack which loads the specimen through a stiff spring, or force-measuring bar, in series with it. No extensometer is needed, as creep is measured by the travel of the screw-jack in maintaining const. load on the test-piece. The deflection of the force-measuring bar at any time is indicated by a dial gauge mounted on it. Automatic recording equipment traces an individual creep curve for each test. Tests last 10–400 hr.—N. B. V.

Proving Rings. —— (*Engineering*, 1947, **164**, (4256), 169–172).—A proving ring is a ring of elastic material of rectangular cross-section, having an axial length some four or five times its radial thickness. When loaded diametrically, the diameter changes by an amount definitely related to the applied load. Rings can be obtained in various capacities, up to 150 tons, to enable testing machines and other equipment to be calibrated and tested for accuracy. A description is given of their characteristic properties and illustrated by line drawings and photographs.—R. Gr.

***Measurement of Young's Modulus at High Temperatures.** M. H. Roberts and J. Nortcliffe (*J. Iron Steel Inst.*, 1947, **157**, (3), 345–348).—R. and N. describe a method by which Young's modulus of metal specimens can be

measured at temp. in the range room temp.–1000° C., with an accuracy of $\pm 2\%$. The specimen consisted of a bar 6 in. long $\times$ $\frac{3}{16}$-in. dia., suspended horizontally in a furnace by two asbestos strings. One of the strings was attached to a small loudspeaker and the other to the needle of a piezo-electric crystal gramophone pick-up. The loudspeaker was driven by a beat-frequency oscillator, and the output from the pick-up was passed through an amplifier to the Y plates of a cathode-ray oscillograph. The oscillator was tuned so as to give max. deflection of the oscillograph (corresponding to the fundamental frequency of the bar) and the frequency was determined with a calibrated frequency bridge placed in parallel with the loudspeaker. Young's modulus was calculated from the equation :

$$E = 1{\cdot}041 \,.\left(\frac{l}{d}\right)^4 .\frac{m}{l}.f^2 \times 10^{-8} \text{ tons/in.}^2$$

where l = bar length in cm., d = bar diameter in cm., f = natural frequency of bar in cycles per second, and m = weight of bar in grammes. A correction for the expansion in the length of the bar was made in all the experiments conducted at elevated temp. An important precaution was that the points of attachment of the strings be close to the positions of the nodes; the nodal points were determined in preliminary experiments and the strings were attached at points 3 mm. distant from these. Results obtained with a number of steels are presented, and these show satisfactory agreement with figures determined by the usual static method.—R. W. R.

***A Direct-Reading Electrical Strain Meter.** F. C. Widdis (*J. Sci. Instruments*, 1947, **24**, (11), 302–303).—A direct-reading strain meter constructed from a portable galvanometer is described. The instrument can be used with all types of commercial electrical strain-gauges. The theory of the instrument and its sources of error are discussed.—W. H.-R.

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Robert, M. *De Quelques Utilisations Particulières du Water-Jacket à Cuivre.* (Centre de Perfectionnement Technique, Cours-conférences No. 1601.) 27·5 × 21 cm. Pp. 20. 1946. Paris: Presses Documentaires. (60 francs.)

***Rummel, Kurt.** Herausgegeben von. *Anhaltszahlen für die Wärmewirtschaft insbesondere auf Eisenhüttenwerken.* Nach Zahlenunterlagen und Versuchsergebnissen, gesammelt vom Verein Deutscher Eisenhüttenleute durch dessen Energie- und Betriebswirtschaftsstelle. 4. Auflage der "Anhaltszahlen für den Energieverbrauch in Eisenhüttenwerken". 29 × 21 cm. Pp. viii + 224, with 223 illustrations and 387 tables. 1947. Düsseldorf: Verlag Stahleisen m.b.H. (n.p.)

Schnadt, Henri M. *New Methods of Study and Analysis of Metals and Their Application to Welded Constructions.* Pp. 250 with 60 illustrations. Brussels: Henri M. Schnadt, 11 Avenue E. Ysaye.

Silman, H. *Chemical and Electroplated Finishes: The Protective Treatment of Metals.* Demy 8vo. Pp. 432, illustrated. London: Chapman and Hall, Ltd. (30*s.* net.)

Skinner, Eugene W. *Science of Dental Materials.* Third edition, revised. 8vo. Pp. viii + 410, illustrated. 1947. Philadelphia, Pa.: W. B. Saunders Company ($4.75); London: W. B. Saunders Company, 7 Grape Street, W.C.2. (24*s.*).

[See *Met. Abs.*, 1937, **4**, 575, for review of first edition.]

***Society for Experimental Stress Analysis.** *Proceedings of the Society for Experimental Stress Analysis.* Volume IV, No. 2. Edited by C. Lipson and W. M. Murray. 4to. Pp. xxv + 128, with numerous illustrations. 1947. Cambridge, Mass.: Addison-Wesley Press, Inc., Kendall Square. ($5.00.)

[Contents: W. G. Pierpont, "Fatigue Tests of Major Aircraft Structural Components"; John R. Low, Jr., and Frank Garofalo, "Precision Determination of Stress–Strain Curves in the Plastic Range"; Henry W. Foster, "A Method of Detecting Incipient Fatigue Failure"; A. F. Underwood and C. B. Griffin, "A Machine for Fatigue-Testing Full-Size Parts"; S. A. Gordon, "Some Repeated Load Investigations on Aircraft Components"; Roy W. Brown, "Stress Analysis Utilization in Dynamic Testing"; W. A. Wallace and W. A. Caster, "Device for Maintaining Continuous Electrical Connections with Reciprocating Engine Parts"; Robert Mayne, "Evaluation of Various Methods of Rotor-Blade Analysis by Means of a Structural Model"; W. H. Pickering, "Reluctance Gauges for Telemetering Strain Data"; Hermann Schaevitz, "The Linear Variable Differential Transformer"; David E. Weiss, "Design and Application of Accelerometers"; Carl L. Frederick, "Aircraft Instruments for Radio-Telemetering and Television-Telemetering."]

***Spectrochemistry.** *Spectrochemical Abstracts.* Edited by Ernest H. S. van Someren. Vol. III. *1940–1945.* Med. 8vo. Pp. 112. 1947. London: Adam Hilger, Ltd., 98 St. Pancras Way, N.W.1. (12*s.* 11*d.*, post free.)

[The subject matter of the book is in two parts. The first is an index section, in which the authors and references are arranged alphabetically under the authors' names; also there is an index to elements in non-metallic substances, and an index to elements in metals. The second part is composed of the abstracts; they are arranged in groups as follows: the substances analysed (biological materials, ceramics and slags, gases and

liquids, minerals and ores, non-metallic solids, and metals), apparatus, methods, source theory, summaries and reviews, and books.]

*Standards Association of Australia. *Aluminium Alloy Bars and Sections.* (Emergency Standard No. (E) 2D. 649.) 4to. Pp. 5. 1946. Sydney: The Association, Science House, Gloucester and Essex Streets. (1*s.* 2*d.*, post free.)

[This entry cancels *Met. Abs.*, this vol., p. 85, lines 13–15 from the top of the page. Copies of the Standard may be obtained from the British Standards Institution, 28 Victoria Street, London, S.W.1.]

de Sy, A. *Algemene Metallurgie.* 8vo. Pp. 248, illustrated. 1947. Antwerp: Uitgeversmij, N. V. Standaard-Boekhandel.

[A text-book of general metallurgy, electrometallurgy, and metallography.]

Thompson, P. F. *Corrosion of Metals. Metals in Aircraft-Engine Cooling Systems.* (Report A.C.A.–24.) 4to. Pp. 54, illustrated. 1946. Canberra, Australia: Australian Council for Aeronautics.

[See *Met. Abs.*, 1947, this vol., p. 38.]

Troescher, Wolfgang F. *Hartverchromung im Werkzeug- und Maschinenbau.* Pp. 67. 1947. Berlin: Werkstatt und Betrieb.

*Zinc Alloy Die-Casters Association. *The Commercial Applications of Zinc Alloy Gears.* Cr. 8vo. Pp. 16, illustrated. 1947. Oxford: The Association, Lincoln House, Turl St. (Gratis.)

NEW JOURNALS

Acta Crystallographica. Will take the place of *Zeitschrift für Kristallographie.* Six issues yearly, published by the Cambridge University Press under the auspices of the International Union of Crystallography; edited by P. P. Ewald. First issue appeared in January 1948. (Annual subscription, 50*s.*)

Archiv für Metallkunde. Published monthly by Verlag Chemie, Heidelberg–Berlin; edited by Walter Koehler. First issue appeared in 1946. (RM. 14 per quarter, post free.)

Chemical Corps Journal. Published quarterly by the Chemical Warfare Association, at 2153 Florida Avenue, N.W., Washington 8, D.C., U.S.A. First issue published in October 1946. ($2.00 per year.)

Electroplating. Covers the subjects of anodizing, enamelling, pickling, lacquering, bronzing, polishing, and phosphating. Published monthly from 83 Udney Park Road, Teddington, Middlesex. First issue appeared in November 1947. (37*s.* 6*d.* per year, post free.)

Metal Powder Report. Edited by W. D. Jones and R. A. Hetzig. Published monthly, mostly for private circulation, by Powder Metallurgy, Ltd., Commonwealth House, 1–19 New Oxford St., London, W.C.1. (£3 7*s.* 6*d.* per year.)

Optik. Published by Wissenschaftliche Verlagsgesellschaft m.b.H., Tübinger Strasse 53, Stuttgart S., Germany. First issue published in July 1946. (RM. 3.50 per single number.)

Research. A Journal of Science and its Applications. Editor: Dr. Paul Rosbaud; deputy editor: D. R. Rexworthy. Published monthly by Butterworth's Scientific Publications, Bell Yard, Temple Bar, London, W.C. 2. First issue published in October 1947. (Yearly subscription 45*s.*, post free.)

Technik. Contains original research reports on technology. Published monthly by Verlag Technik, Berlin; edited by X. Gehlhoff. First issue appeared in July 1946. (18 RM. per half year.)

Zeitschrift für Naturforschung. Published monthly by Dieterich'sche Verlagsbuchhandlung, Spiegelgasse 9, Wiesbaden, Germany. First issue published in November 1945. (Price per number varies but is generally about RM. 4.)

XXV.—BOOK REVIEWS

Handbook of Industrial Electroplating. By E. A. Ollard and E. B. Smith. Demy 8vo. Pp. 287, with 97 illustrations. 1947. London: Iliffe and Sons, Ltd. (15*s*. net.)

This book is a collection of data selected as likely to be useful to those concerned with designing, erecting, or working electrodeposition plants and with the maintenance of solutions or the testing of deposits. It is divided into eight sections, dealing with: electrical equipment and distribution (43 pp.), deposition plant (50 pp.), selected compositions and conditions of use of solutions for cleaning, pickling, plating, anodizing, colouring, &c. (46 pp.), special formulæ (6 pp.), methods of testing solutions (39 pp.) and deposits (25 pp.), and various glossaries (19 pp.) and miscellaneous information and tables (46 pp.); an index (5 pp.) and a list of tables are included.

The book is designed as a comprehensive guide to electroplating, and the authors have included a vast amount of useful information in a relatively small volume which is clearly arranged and well bound. In a book of this type, especially in the first edition, it is not difficult to find points to criticize. The most important criticism is the omission, except for a few isolated references, of any indication of the source from which the information has been drawn; this omission might be less serious if the authors had not specifically disclaimed responsibility for all formulæ, methods, and data, without indicating those for which they could vouch. The inclusion of references where the reader might seek further guidance or be able to verify facts would no doubt be a formidable task, but it would transform the value of the sections on solution formulæ and methods of testing. Most of the errors and omissions noticed during a perusal of the book were of a relatively minor nature, e.g. omissions: centrifugal pumps, analysis of brass-plating solutions; incomplete: the section on stripping of deposits and thickness measurement by stripping, and the section on electrolytic polishing; errors: no unit of weight in formula 1 (p. 193), and 6 lb./gal. is 600, not 60, g./l. (p. 194).

These criticisms are intended to be constructive (i.e. for attention in a second edition) rather than destructive, for the book contains too much useful matter to allow it to be overlooked or omitted from the bookshelf of anyone concerned with the operation of electroplating plant or with the control of its products.—A. W. Hothersall.

Recent Progress in Electroplating and Metal Finishing; German Work on Bright Metal Plating; Recent Work on Black Nickel Plating; Phosphatizing Treatments on Metals for Press-Work, Internal-Combustion Engine Parts, &c. (The Technical Progress Series, 2. Electroplating and Metal Finishing, Part 1.) Cr. 8vo. Pp. 48. 1946. London: Hood-Pearson Publications, Ltd., 45 Gerrard Street, W.1. (3*s*. 6*d*.

A Concise Guide to the Colouring of Metals. (The Technical Guidance Manuals, 1 and 2.) Cr. 8vo. Part 1.—Pp. 76, with 19 illustrations. Part 2.—Pp. 72, with 21 illustrations. 1946. London: Hood-Pearson Publications, Ltd., 45 Gerrard Street, W.1. (3*s*. 6*d*. per part.)

The booklet on electroplating and metal finishing purports to be a "review of German and other practice in recent years". Four chapters (38 pp.) are devoted to the processes and practice of bright metal plating, with special reference to bright nickel plating. The treatment is sketchy and sometimes inaccurate (e.g. "bright nickel coatings have been proved to be non-porous"), and the almost complete absence of references robs the publication of any value it might have had as a review. The final chapter (10 pp.) is a useful general account of the application of phosphate coatings to steel for the purpose of helping deep drawing.

The first of the two booklets on metal colouring gives a fairly extensive series of methods for the chemical colouring of metals and includes information on the range of colours obtainable by alloying and by heat-tinting. Part 2 gives an interesting chapter on methods of producing multi-coloured and black finishes on anodized aluminium, a chapter on black nickel plating, one on miscellaneous finishes (black on stainless steel, "blue gelatine copper colouring", and rainbow plating), and a fourth on the alkaline-oxidation method of producing black coatings on steel. Some experimental results are given and some references are included in Part 2. Bearing in mind their size, price, and anonymity, these two booklets will be found useful, both for their general interest and for their practical information.—A. W. Hothersall.

Chemistry for Electroplaters. By C. B. F. Young. Demy 8vo. Pp. vii + 205, with 6 illustrations. 1945. Brooklyn, N.Y.: Chemical Publishing Co., Inc. ($4.00.)

This book is written in narrative form, without sub-headings. One is led gradually, very gradually at first, through the chemistry of the various elements, beginning with oxygen, hydrogen, and chlorine; explanations of fundamental principles are interspersed, e.g. of the atomic theory, chemical equations and calculations, acids and bases, true and colloidal solutions, &c. A few (generally ten) questions are given at the end of each chapter; answers ars not provided. An extensive index (19 pp.) is included.

The author has produced a very readable book, which contains the essentials of the subject. He has succeeded admirably in his purpose of making available to an enquiring but uneducated mind the working knowledge of elementary inorganic chemistry which is necessary for an appreciation of the science of electroplating.—A. W. Hothersall.

Induction Heating. Lectures by H. B. Osborn, Jr., P. H. Brace, W. G. Johnson, J. W. Cable, and T. E. Eagan. Med. 8vo. Pp. [v] + 172, with 113 illustrations. 1946. Cleveland, O.: American Society for Metals, 7301 Euclid Avenue. ($3.00.)

This book brings under one cover a series of five educational lectures on induction heating, presented to the American Society for Metals at the Twenty-Seventh National Metal Congress held at Cleveland in February 1946.

The first paper by H. B. Osborn, Jr., serves as an introduction to the subject and reviews the principles and theory of high-frequency heating. Fundamental relationships between frequency and the depth of energy penetration in the work, and the effect of time of treatment on the depth of hardened zones on steel are briefly reviewed and translated into the requirements for practical application. Control factors are presented for intermittent and for continuous working, as well as for through-heating, and the accompanying charts relating power input and frequency to the depth of heat penetration and to the mass of work treated are of particular interest.

The use of theoretical equations relating the minimum optimum frequencies to specific applications is discouraged on the score of complexity and misrepresentation. It is difficult to reconcile this probably justifiable argument with the very arbitrary approximate equations which are submitted as alternatives. It is surprising also that no distinction is made between conditions for the treatment of magnetic and non-magnetic materials.

P. H. Brace, in a paper that is essentially electrical, deals in an elementary way with induction-heating circuits and outlines the operation and characteristics of the associated generating equipment. The latter includes the spark-gap oscillator (15–30 kc./s.), the motor alternator (1–10 kc./s.), the mercury-arc converter (0·5–1·5 kc./s.), and the valve oscillator (above 10 kc./s.). This paper is well written, but would have been improved if less had been said on the details of valve design and more on the alternative high-frequency generators, which are discussed all too briefly. Power factors and power efficiencies are compared, but with the absence of information on the general overall efficiencies of the various generators, such data are of secondary importance.

The papers by W. G. Johnson and J. W. Cable are devoted to practical applications, the former for frequencies below and the latter for frequencies above 100 kc./s. Numerous practical examples are described, including surface and through-hardening, welding, brazing, soft soldering, melting, and dielectric heating. Of particular interest is the section on residual stresses in induction-hardened parts which, in general, have an adverse effect on fatigue resistance. The evaluation of the stresses, and the corrective measures which can be applied (in particular, cold working) are discussed fairly fully.

Coil design is one of the primary factors affecting the successful application of high-frequency heating, and it is surprising to find this dealt with very summarily in the paper by Cable. Perhaps it would have been preferable to have omitted even this reference to it, rather than to imply, by its cursory treatment, that it is of second-order importance.

The final paper by T. E. Eagan gives "A Comparison of Induction Heating with Other Methods of Heat-Treating" and is by no means as comprehensive as the title would suggest. Most of the paper is devoted to a discussion on the relative merits of flame and of induction hardening, with a final section on the advantages of induction hardening of carburized steel as compared with conventional furnace methods.

The most attractive features of this book are the illustrations, which are excellently reproduced and informative. The text, however, does not read easily, with a frequent lack of continuity, and leaves the impression that little effort has been made to redraft the original lectures before publication. While the book will be of interest to the practical man who is desirous of having an introduction to the subject, there is little of a fundamental nature which will be of value to the student.—Ivor Jenkins.

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PRINTED IN GREAT BRITAIN BY RICHARD CLAY AND COMPANY, LTD., BUNGAY, SUFFOLK.